

Editorial

# Special Issue: Valorization of Material Waste for Environmental, Energetic, and Biomedical Applications

Antonio Gil 

INAMAT2 Science Department, Campus of Arrosadia, Public University of Navarra, Building Los Acebos, 31006 Pamplona, Spain; andoni@unavarra.es

## Preface

Waste management and its recovery to provide it with added value are increasingly important lines of research that fall within the concept of a *Circular Economy*. Reducing the amount of waste that is generated is no longer only the objective; at present and in the future it is necessary to achieve a utility for this waste that contributes effectively to the scarcity of raw materials, as well as the impossibility of storing any type of waste.

The development of materials and products from industrial waste has attracted the attention of the research community for years. The physicochemical characteristics have specific impacts on the material properties and the materials and products are applied in environmental, energetic, and biomedical areas such as pollutant removal, CO<sub>2</sub> capture, energy storage, catalytic oxidation and reduction processes, conversion of biomass to biofuels, and drug delivery. Examples of materials are activated carbons, clays, and zeolites, among others. The aim of this Special Issue is to compile the recent advances and progress in relation to valorized materials from industrial waste and their applications in environmental, energetic, and biomedical areas.

This book contains up to eight papers published by several authors interested in the valorization of materials and in the concept of a *Circular Economy*. Voultsov et al. [1] evaluate the energetic and environmental performance of a cogeneration biomass gasification plant, situated in Thessaly, Greece, via a methodology combining process simulation and Life Cycle Assessment (LCA). Initially in the work, the gasification process of the most common agricultural residues found in the Thessaly region is simulated to establish the effect of technical parameters such as gasification temperature, equivalence ratio, and raw biomass moisture content. The gasifier model is up-scaled by the authors, achieving the operation of a 1 MW<sub>el</sub> and 2.25 MW<sub>th</sub> cogeneration plant. The LCA of the operation of the cogeneration unit is conducted using the performance data from the process simulation as input. Global Warming Potential and the Cumulative Demand of Non-Renewable Fossil Energy results suggest that the component which had the major share in both impact categories is the self-consumption of electricity of the plant. The results obtained by the authors suggest that plant operation in all examined conditions leads to GHG mitigation and non-renewable energy savings of approximately 0.6 kg CO<sub>2</sub>eq/kWh<sub>el</sub> and 10 MJ/kWh<sub>el</sub>, respectively.

The methods to treat kinetic data for the biodegradation of various plastic materials are comparatively discussed in the work by Rossetti et al. [2]. Several samples of commercial formulates were tested for aerobic biodegradation in compost, following the standard ISO14855. Starting from the raw data, the conversion vs. time entries were elaborated using relatively simple kinetic models, such as integrated kinetic equations of zero, first, and second order; the Wilkinson model; or the Michaelis Menten approach.

Tam et al. [3] report that Q9 is widely used in industries handling flammable fluids and is central to explosion risk assessment (ERA). Q9 transforms complex flammable clouds from pressurized releases to simple cuboids with uniform stoichiometric concentration, drastically reducing the time and resources needed by ERA. Q9 is commonly believed in the industry to be conservative, but two studies on Q9 gave conflicting conclusions. This



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efficacy issue is important, as impacts of Q9 have real life consequences, such as inadequate engineering design and risk management, risk underestimation, etc. The authors review published data and describe additional assessment on Q9 using the largescale experimental dataset from Blast and Fire for Topside Structure joint industry (BFTSS) Phase 3B project, which was designed to address this type of scenario. The presented results show that Q9 systematically under-predicts this dataset. Finally, the authors make several observations and recommendations.

Bächle et al. [4] also report that for solid–liquid separation, filter meshes are still used across large areas today, as they offer a cost-effective alternative, for example, compared to membranes. However, particle interaction leads to a continuous blocking of the pores, which lowers the flow rate of the mesh and reduces its lifetime. This can be remedied by filter aids. In precoat filtration, these provide an already fully formed filter cake on the fabric, which acts as a surface and depth filter. This prevents interaction of the particles to be separated with the mesh and thus increases the service life of the mesh. In the work, the effect of a precoat layer with fiber lengths of cellulose on the filtration behavior is investigated.

In the following, the authors indicate that the dispersion of vapor of liquefied natural gas (LNG) is generally assumed to be from a liquid spill on the ground in hazard and risk analysis [5]. The authors also explain that the cold vapor could be discharged at a certain height through cold venting. While there is similarity to the situation where a heavier-than-air gas (e.g., CO<sub>2</sub>) is discharged through tall vent stacks, LNG vapor is cold and induces phase change of ambient moisture, leading to changes in the thermodynamics as the vapor disperses.

Beltran-Siñani and Gil [6] present that waste generation is one of the multiple factors affecting the environment and human health that increases directly with growing population and social and economic development. The municipal solid waste disposal sites and their management create climate challenges worldwide, with one of the main problems being high biowaste content, which has direct repercussions for greenhouse gas (GHG) emissions. In the case of Bolivia, as in most developing countries, dumps are the main disposal sites for solid waste. These places are usually non-engineered and poorly implemented due to social, technical, institutional, and financial limitations. Composting plants for the treatment of biowaste appear to be an alternative solution to the problem. In this way, municipalities have implemented pilot projects with successful social results; however, access to economic and financial resources for this alternative are limited. The authors compile and summarize the Intergovernmental Panel on Climate Change (IPCC) guidelines methodology and some experimental procedures for the accounting of greenhouse gas emissions during the biowaste composting process as an alternative to its deposition in a dump or landfill.

Conventional water treatment technologies are not capable of removing estradiol from water, as indicated Pérez-González et al. [7]. Their study aims to assess a method that combines physicochemical and biological strategies to remove estradiol even when there are other compounds present in the water matrix. Na-montmorillonite, Ca-montmorillonite, and zeolite were used to remove estradiol in a medium with sulfamethoxazole, triclosan, and nicotine using a Plackett–Burman experimental design. Each treatment was followed by biological filtration with *Daphnia magna*. The most significant factors for estradiol adsorption were the presence of nicotine and triclosan, which favored the adsorption; the use of Ca-montmorillonite, Zeolite, and time did not favor the adsorption of estradiol.

In the final manuscript, Riley et al. [8] present a work where the extraction of Cu from mixed-metal acidic solutions by the thiourea-functionalized resin Puromet MTS9140 was studied. Despite being originally manufactured for precious metal recovery, a high selectivity towards Cu was observed over other first-row transition metals (>90% removal), highlighting the potential for Puromet MTS9140 in base metal recovery circuits. Resin behavior was characterized in batch mode under a range of pH and sulphate concentrations and as a function of flow rate in a fixed-bed setup. In each instance, a high selectivity

and capacity towards Cu was observed and was unaffected by changes in solution chemistry. The work is the first detailed study of a thiourea-functionalized resin being used to selectively target Cu from a complex multi-metal solution.

**Conflicts of Interest:** The authors declare no conflict of interest.

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## Short Biography of Author

**Antonio Gil** (Full Professor of Chemical Engineering, Universidad Pública de Navarra, Spain): Professor Gil earned his BS and MS in Chemistry at University of Basque Country (San Sebastián), and his PhD in Chemical Engineering at University of Basque Country (San Sebastián). He did postdoctoral research at the Université catholique de Louvain (Belgium) working on Spillover and Mobility of Species on Catalyst Surfaces.

The research interests of Professor Gil can be summarized as: Evaluation of the porous and surface properties of solids. Pillared clays. Gas adsorption. Energy and CO<sub>2</sub> storage. Pollutants adsorption. Environmental technologies. Environmental management. Preparation, characterization and catalytic performance of metal supported nanocatalysts. Industrial waste valorization.